APPLICATION FOR UNITED STATES PATENT

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TITLE: ~~DATA RECORDING DEVICE WITH HERMETIC, REMOVABLE AND SUSPENDED CARTRIDGE~~

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Data Recording Device with Hermetic, Removable and Suspended Cartridge

This invention relates to the technical sector of data recording (and storage) in a severe environment and, particularly but in a nonrestrictive manner, it pertains to devices intended to equip airliners, combat aircraft, ships, helicopters, combat vehicles such as, for example, armored vehicles, spacecraft and similar equipment.

This invention relates to the storage and recording of all types of data, that is, numerical, audio and especially video data in a nonrestrictive fashion, however, and including types of data that can appear in the future.

In this general context, we are familiar with storage and recording on magnetic tape, but we prefer storage and recording in a "cartridge," that is to say, a hermetically sealed box, for example, a hard disk with its reading and recording device, comprising an "arm" in the conventional fashion.

The hard disks concerned here are those that are sold, especially disks with a format of 22" or 32", as usual, or any other hard disk or similar system that could appear in the future.

As the expert in the field will understand, the invention also applies to any other data storage and recording support that is contained in the box that must be hermetically sealed and that must be handled so as to be extracted from its housing after a given mission or operation and that must then be reinserted in that same housing for the next mission or operation.

In this connection, we will also cite in a nonrestrictive manner the semiconductor memories and any other technology having an equivalent, current or future function.

By "hermetic," we mean here the vacuum-tight elements, that is to say, those that have a zero or extremely low leakage rate in a vacuum environment or under very low ambient pressure.

By "tight," we mean watertight or humidity-tight elements.

In the above-mentioned environments, the equipment in the well-known fashion is subject to difficult or extreme conditions of vibration and/or vacuum (altitude) and/or shocks and similar constraints.

The most difficult problem to be solved here is the problem of altitude and, hence, the more or less forceful pressure drop to which the equipment will be subjected.

As a matter of fact, pressure differences, exerted on a non-hermetic device, will bring about incoming and outgoing flows of atmosphere in the box and hence produce condensation phenomena. Moreover, in the case where the cartridge contains a hard disk, the arm will not remain at a predetermined distance called the aerodynamic distance from the disk, but on the contrary will entail the risk of being placed on the disk and thus scratching it, causing deteriorated recordings.

It is thus necessary to resort to hermetically sealed boxes and boxes that are generally "suspended," that is to say, they are mounted on shock absorbers capable of reducing the shocks and vibrations undergone in the environments concerned to inoffensive values.

It is also necessary to have a sufficient number of electrical contacts between the box (cartridge) and its support in the recorder to ensure the necessary transmissions of signals.

According to currently customary data processing standards, one must have about 50 contacts for the IDE standard and 80 for the SCSI standard by way of nonrestrictive examples.

However, recorders, especially those mounted in aircraft, must have as small dimensions as possible for obvious reasons of weight and bulk and the surface area available for contacts is thus reduced. This means that the contacts must themselves have small dimensions.

Another urgent requirement is that said contacts must, without any harmful wear and tear, resist a large number of "insertions," that is to say, connection/disconnection cycles and especially without displaying any wear and tear that would induce parasite resistances that would affect the data. Military-type connectors, which we are familiar with in the field concerned, that is, the SUB-D or HILC 38999 type, can take 200 to 400 insertions. The chip card connectors must withstand about 5,000 insertions.

It is also absolutely necessary that the cartridges be easily handled, that is to say, they must be easily extracted, transported and put back in place without any special precautions nor any special tools and even in a hostile or difficult environment. Thus, the boxes must be capable of being handled by technicians at airport runways, possibly with hands wearing thick gloves, and they must withstand shocks such as those that result from being dropped and similar ones encountered in routine use.

The devices must therefore be compact, light, sturdy, hermetic, easily handled, obviously reliable, they must present a large number of contacts on as small a surface as possibly and they must be capable of withstanding a large number of insertion cycles, for example, on the order of 3,000 without any damaging wear and tear, and they must present an extraction and engagement mechanism that itself must be compact, simple, sturdy, obviously reliable, obviously very precise, especially in terms of electrical contacts that also must be easily handled, including with gloves, and this, of course, must not require any excessive force (entailing the risk of damaging the shock absorbers). The simple listing of these objectives underscores the difficulty of this undertaking because any expert in the field will understand that practically all of these criteria are antagonistic.

Furthermore, to this very day, there is no connector capable of meeting all of these criteria. The only connectors that come close to some of these parameters are connectors for memory cards, but they are infinitely too fragile and absolutely unsuitable for the environments contemplated for the invention.

We also know of connectors called "hermetic lead-through" of the type shown in Figure 1, attached.

Other features and advantages of the invention will appear more clearly upon reading the following description and referring to the attached drawing where:

- shows a "hermetic lead-through" contact of prior art;
- Figure 2, made up of Figures 2a, 2b and 2c, shows three nonrestrictive examples made for the sake of simplicity in a single figure showing couples of "studs" and of "studs" forming the connection according to the invention;

- Figure 3, made of up Figures 3a and 3b, shows the final phase involved in engaging cartridge 40 in receptacle 30 with Figure 3a corresponding to pre-engaging and Figure 3b showing the completed engagement;

- Figure 4 shows the way to mount a stud in the wall of cartridge 40 according to the invention;

- Figure 5 shows a special nonrestrictive means for locking the shock absorption of receptacle 30 in the "cover of box 70 open" position;

- Figure 6, made up of Figure 6a and 6b, shows the method used in engaging the pin 120 in sleeve 105 according to the preferred embodiment of the invention;

- Figure 7 also shows the engagement phase according to the invention.

On the attached figures, the same references have the same meanings, to wit:

1 female contact (prior art)

2 male contact or "plug" (prior art)

3 metallic support or "case" (prior art)

4 hermetic glass welding (prior art)

5 rear connection of contact, especially toward a printed circuit board not shown

10 elastic "plug"-type contact of the spring-piston type according to the invention

11 base of spring plug for mounting on printed circuit in nonrestrictive examples shown

12 contact of "stud" type according to the invention, intended to cooperate with elastic plug 10

16 variant of shape of stud 12 according to the invention

18 other variant of shape of study 12 according to the invention

30 support or "receptacle" of cartridge, incorporating a connection plate 95, comprising plug contacts 10

40 cartridge (face bearing connection with "studs" 12 (or 16 or 18 or other variants within the immediate reach of the expert in the field)

45 connection rod for stud 12 (or 16 or 18 or other variants within the immediate reach of the expert in the field)

46 stud head

47 stud covering (generally a thin layer of gold)

60 stud protection layer (generally resin)

70 closing hood of box (opening according to arrow (1))

75 "prismatic" piece or cam integral with hood

80 rod or other control piece

85 mechanical safety unit (containing a return spring)

87 axis of rotation along arrows (2) and (3) when the hood is open

(M) shock and vibration absorption movements of receptacle 30 (only movements perpendicular to the faces of the receptacle are considered here)

90 retractable chocks:

hood of box 70 closed >>> chock in high position permitting movements (M) of receptacle 30; hood open >>> chock in low position blocking movements (M));

100 engaging clip of cartridge 40

105 glue for fitting or clipping protuberance 120, preferably semi-cylindrical

110 piece for engagement of receptacle 40 of cartridge and support of protuberance 120, which is a cylindrical pin in preferred embodiment of the invention

120 protuberance intended to cooperate with groove 105, which protuberance is a cylindrical pin in a preferred embodiment of the invention

140 "U"-shaped piece, support of protuberance 120, which protuberance is a cylindrical pin in a preferred embodiment of the invention, the "U"-shaped piece 140 being adapted to receive clip 100 and cooperate with it and especially with groove 105

200 box

300 shock absorber of receptacle (generally a three-dimensional shock absorber)

In the attached Figure 1 (prior art), we can see that to make a single contact, it is necessary to provide a plug 2, cooperating with a female contact 1 (or inversely), the female member having to guide the plug. The assembly is maintained in a support or "case" 3 by means of a hermetic joint 4 formed by a glass welding, that is to say, a hermetic joint obtained by heating the assembly in the known fashion to about 600-700□C until the glass forms a semi-liquid phase, bringing about a tight vacuum ("hermetic") connection upon cooling. The plug and the female contact each are connected to a standard connection device such as a printed circuit or similar device, for example, at 5. The plug has a screwing button that applies a strong insertion or extraction force on the contacts along the

longitudinal axis of the connection. Such a force is not compatible with the urgent requirements of the invention according to which the necessary force must be weak so as to facilitate handling and, above all, not to damage the shock absorption systems (in the devices shown by this invention, the masses, suspended by the shock absorption means, are light and consequently the shock absorbers are flexible; an excessively strong force would damage them irremediably and the device could no longer be suitably suspended with the obvious serious consequences as regards the reliability of measures and the system). Such known devices, furthermore, have very large dimensions with diameters on the order of 3 to 5 cm housing about 40 contacts. Furthermore, they do not make it possible mechanically to lock the cartridge. For these various reasons, their so-called "insertion" technology is not suitable for the invention.

The invention proposes a solution that is not an insertion but rather a "contact" in spite of the contradictory requirements mentioned above.

Generally speaking, the invention relates to a process for making a connection between a cartridge 40, comprising a data recording and storage means and its receptacle 30, characterized in that the connection is made by contact and not by insertion and that the contact is made for each electrical contact by the cooperation of a plug 10 mounted elastically by a means 11 on receptacle 30 and a stud 12, 16 or 18 mounted on cartridge 40.

The advantage inherent in the contact technology is that it eliminates the constraint represented by precision axial guidance that is mandatory in case of insertion as in Figure 1.

The solution is not obvious because it was also recalled that the problem posed here, among other things, was to provide a light and compact system not requiring a strong cartridge insertion or extraction force and easily handled with gloved hands or the like.

According to the invention, we propose quite generally a data storage or recording device for a severe environment that can possibly be mounted on land vehicles or on ships or aircraft or space vehicles of any type of the kind comprising a recording cartridge 40 (with hard disk or other data support) and a receptacle (or cartridge support) 30 that is "suspended" (that is to say, it is kept in position by preferably multidirectional shock absorbers), characterized in that the connection between the cartridge and its receptacle is made by contact and not by insertion and that the contact for each electrical contact is made by the cooperation of a plug 10 mounted elastically by means 11 on receptacle 30 and a stud 12, 16 or 18 mounted on cartridge 40 in a hermetic manner.

The invention provides a solution that accommodates all of the required parameters with the help of a data storage or recording device for a severe environment that can possibly be mounted on a land vehicle or a ship or an aircraft or a space vehicle of any type of the kind comprising a recording cartridge 40 (with hard disk or other data support) and a receptacle (or cartridge support) 30 that is "suspended" (that is to say, it is kept in position by preferably multidirectional shock absorbers), characterized in that:

- the connection between recording cartridge 40 and suspended receptacle 30 is made by as many couples of "plug 10"/"stud 12 or 16 or 18" as there are required contacts;

said plugs 10 go through the wall of receptacle 30 and present a protuberant portion with a spherical or rounded or similar shape;

and they are mounted on an shock absorption and return means 11

and said studs 12 or 16 or 18 go through the wall of the cartridge box 40 and present a slightly protuberant part with a concave shape 12, with a plane shape 16 or a slightly convex shape 18;

said plugs 10 and said studs 12 or 16 or 18 are geometrically adapted in terms of shape and dimension to cooperate and create an effective electrical contact when one makes receptacle 30 and cartridge 40 face each other;

- cartridge 40 and receptacle 30 comprise engagement means capable of positioning other plugs 10 and studs 12, 16, 18 opposite each other so as to make an effective electrical contact and to ensure the mechanical hold of cartridge 40.

The expert in the field will understand that the shape of the plugs and the studs is not restrictive here and is given only way of illustration. One might prefer plugs whose head will have a generally spherical or rounded shape at the top and studs 46 with a slightly concave head (Figure 4) (12) or in a less preferred manner with a flat head (Figure 2b, 16) or in an even less preferred manner slightly convex (Figure 2c, 18).

Generally speaking, the expert in the field will know how to visualize -- if necessary, by means of routine tests -- the adapted shapes to create an effective electrical contact by means of contact.

In this entire patent application, the terms "plug" and "studs" are intended to designate all of these shapes either described here or accessible to the expert in the field.

As shown in the diagrams in Figure 5 and Figure 2, the plugs (and, respectively, the studs) will preferably be positioned in a plate 95 of receptacle 30 (or, respectively, of the contact face of cartridge 40) naturally in a nonrestrictive manner. One could provide other devices such as, for example, several zones opposite each other and similar arrangements within the reach of the expert in the field.

Figure 4 shows a preferred manner of assembling the plugs in the wall or contact face of cartridge 40.

The invention also relates to a process for mounting the studs according to which stud 12 (or 16 or 18) is positioned by its rod 45 in an adaptive opening in wall 40 by means of a known glass welding 4 after which one deposits around head 46 a mold of protective material 60 such as a resin.

The stud will preferably be made of metal or an alloy with a very high electric conductivity and it will preferably in the known manner comprise a fine gold coating 47 or a coating of an equivalent metal or alloy promoting electrical contact between the plug and the stud.

As noted earlier, recording cartridge 40 is intended to be removed from its support or receptacle 30, for example, upon return from a mission so that its content may be processed. The process must then be repositioned on its receptacle for the next mission with as perfect an electrical contact as possible.

The solution to this problem is not evident because it is advisable perfectly to position the connection arrangement whose contact surface is very small for each stud/stud couple.

The invention works via engagement/disengagement, performing a complex movement that will be described below.

In Figure 3a (and on Figure 7), we showed the position of cartridge 40 and receptacle 30 (or cartridge support just prior to engagement). One can see that cartridge 40 is integral with its lower portion with at least one and preferably two (possibly more) clips 100 comprising a groove 105 capable of cooperating by tight fitting with a protuberant part 120 that is integral with an engagement piece 110, 140 in the shape of a "U," which itself is integral with receptacle 30, cooperation being governed by mechanical means such as the engagement movement of the clip or clips in the "U" leading to "pre-engagement" by a slightly exaggerated descent of the clip of the cartridge with respect to protuberance 120 followed by "final engagement" through the fact that said clip is raised again to lead to a tight fit of groove 105 and protuberance 120.

The engagement process involves absorbing the engaging action by making the clip or clips 100 slide (movement "A," Figure 5a) in the "U" opening of engagement piece 110, 140, seeing to it that groove 105 will descend slightly further down that the corresponding protuberance 120 (Figure 3a) after which one ends the engaging action by putting the contact face of cartridge 40 on the contact face of receptacle 30, movement "B," Figure 3b, and by allowing the two faces to be positioned via a slight rise (movement "C," Figure 3b) and by tight fitting of groove 105 with protuberance 120 at the end of this rising motion.

According to the preferred embodiment of the invention, protuberance 120 is a cylindrical pin and corresponding groove 105 is a semi-cylindrical groove so adapted as to receive pin 120 in a tight fitting. With the help of this term, the expert in the field will understand that there is no leeway after engagement.

During the above-described engagement action, cylindrical pin 120 rests (see Figure 6a) on the edge of groove 105 and the compression effort that is applied when the cartridge compresses the plugs causes the pin to roll (see Figure 6b) in the center of the groove.

According to this process, one understands that the slight rise of the cartridge during final engagement, which represents an extremely small distance of about 0.2 to 0.5 mm while each stud comes into contact with each plug, will be expressed by a perfect self-cleaning of the contact surfaces. During this movement, there is no wear and tear that one might fear and that would be damaging; tests showed, on the other hand, that the effective service life of contacts thus self-cleaned was definitely longer than the effective service life of the cartridge.

As also indicated above, it is important that the operator not be forced during the placement of cartridge 40 to apply excessive forces on receptacle 30 that could damage the shock absorbers.

We know that the device made up of the receptacle and the cartridge as well as by various other known elements are of course understood to be contained in a resistant and tight box. One gets at the cartridge, housed in its receptacle, by opening a hood 70 (see Figure 5).

The invention proposes a device that comprises a mechanical means for the temporary automatic locking of [spring-back] shift (M) of receptacle 30 to protect the shock absorbers during the extraction phase and the phase in which the cartridge is put back in its receptacle.

The solution involved in the invention consists (Figure 5) of a device that comprises a mechanical means for the temporary automatic locking of the shift (M) of receptacle 30 when one opens hood 70 of the box to gain access to the cartridge and the same means again permits the normal [spring-back] shift (M) of receptacle 30 during the closing of the hood, that is to say, after one has put a cartridge back in place by means of engagement on the receptacle.

The importance of locking the shift is that one protects the shock absorbers since they -- regardless of the force that is exerted -- are no longer stressed along direction (M).

Figure 5 shows a particular nonrestrictive means for temporary locking, characterized in that it comprises a prismatic piece or a cam 75 comprising an inclined face that is integral with hood 70 and a retractable chock 90 that is integral with a piece 85 constituting the mechanical safety unit considered, said piece itself being integral with a control rod 80 or a similar piece capable of cooperating with cam 75 via contact sliding on the inclined surface of said cam or prism, the entire piece forming the chock being mounted in a rotating manner around the longitudinal axis 87 of unit 85, and this assembly comprises a return means such as a spring or a similar device, tending to lower the chock 90 behind the contact face of receptacle 30 and the various geometries, shapes and positioning of the various pieces are adapted so that the opening of hood 70 (and thus of cam 75) according

to movement (1) by sliding would release control rod 80, which then moves due to the action of the return means, not shown, according to movement (2) to which corresponds movement (3) of chock 90, a movement that positions said chock 90 behind receptacle 30, the thickness and positioning of chock 90 being so adapted that in this position the shock absorption (or spring release shift) movement (M) of the receptacle will be impossible.

One can then return the cartridge in place without the receptacle being able to act on his shock absorbers according to movement (M) since that movement is prevented by chock 90 and there is therefore no risk of deforming said shock absorbers.

When one closes the hood again, the inverse movement raises chock 90, which is then positioned above the receptacle, thus again permitting shock absorption movement (M).

According to a nonrestrictive embodiment of the invention, the return force for plugs 10 is on the order of 1 N for each plug.

According to a preferred but nonrestrictive embodiment, the shock absorption or return means 11 for plug 10 is a spring or a piston, preferably a small piston.

The system described in Figure 5 can also be used as detector for the opening of the hood. It is then absolutely necessary that the cartridge no longer be under stress when one extracts it, but rather, when the cartridge, for example, comprises a disk and an arm, the latter should be stopped and should rest on the disk; one can easily understand that the further movements imparted to the cartridge during its transport will be transmitted to the arm, which will damage the disk and the recorded data. On the other hand, if power supply

to the cartridge is cut off prior to extraction, the arm is automatically placed in the so-called "parking" position where it cannot damage the disk.

The system in Figure 5, according to a particular embodiment, comprises a means adapted for automatically cutting the electric power supply to the cartridge when hood 70 is opened.

Such a means, for example, will be an opening detection contact of the known type, mounted partly on the hood and partly on the portion of the box containing cartridge receptacle 30.

The expert in the field will know how to visualize other equivalent means.

The invention also relates to applications of devices and processes described for recording and storage of data on the ground or mounted on a land vehicle or a ship or an aircraft or a space vehicle of any type.